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| APPLICATION NO.   | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|---|-------------|----------------------|---------------------|------------------|
| 10/733,650  | 12/11/2003  | Hyung Jun Kim        | CU-3486 RJS         | 2168             |
| 26530   | 7590        | 10/19/2004           | EXAMINER            |                  |
| LADAS & PARRY LLP<br>224 SOUTH MICHIGAN AVENUE<br>SUITE 1200<br>CHICAGO, IL 60604 |             |                      | LEE, CALVIN         |                  |
|   |             |                      | ART UNIT            | PAPER NUMBER     |
|   |             |                      | 2825                |                  |

DATE MAILED: 10/19/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

## Office Action Summary

Application No.

10/733,650

Applicant(s)

KIM, HYUNG JUN

Examiner

Lee, Calvin

Art Unit

2825

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

### Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

### Status

- 1) ☒ Responsive to communication(s) filed on 8/31/04 (Amendment A).
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

### Disposition of Claims

- 4) ☒ Claim(s) 1-13 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-13 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

### Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 12/11/03 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

### Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some \* c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

### Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)  
Paper No(s)/Mail Date 9/3/04.
- 4) ☐ Interview Summary (PTO-413)  
Paper No(s)/Mail Date. \_\_\_\_\_.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: \_\_\_\_\_.

## OFFICE ACTION

### *Opening Comments*

1. After a closer review of the Applicant's arguments and after further search related arts, the examiner has found a new piece of art, US 2003/0073593 to *Brigham et al*, which would read on the applicant's claims. Therefore, following is a new ground of rejections.

### *Claim Rejections - 35 U.S.C. § 103*

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

3. Claims 1-2 and 4 are rejected under 35 U.S.C. 103(a) as being unpatentable over *Curry, II et al* (US 5,137,597) in view of *Brigham et al* (US 2003/0073593).

*Curry, II et al* discloses a method for polishing a copper layer, comprising the steps of:

- a) forming a first sacrificial layer pattern **14a** having a first trench **20a** on a substrate **12a** [Fig. 13a]
- b) continuously forming a first copper layer **24a** on a sidewall of the first trench, a bottom surface of the first trench, and the first sacrificial layer pattern [Fig. 14]
- c) polishing the first copper layer through a CMP process [Fig. 15], thereby exposing a surface of the first sacrificial layer pattern
- d) removing the first sacrificial layer pattern to a height of the first copper layer formed on the bottom surface of the first trench [col. 5, ln.43], thereby forming trench structure having the first trench filled with the first copper layer [Fig. 16]
- e) forming a second sacrificial layer pattern **50b** having a second trench, which exposes the trench structure, on the first sacrificial layer pattern **14a** having the trench structure [Fig. 19]
- f) continuously forming a second copper layer **24c** on a sidewall of the second trench, a bottom surface of the second trench, and the second sacrificial layer pattern [col. 6, ln.15], wherein the first and second copper layers are formed by electroplating techniques [col. 1, ln.37]
- g) removing the second copper layer to expose a surface of the second sacrificial layer pattern

*Curry, II et al* suggests polishing copper layer **24a** through a CMP process, in which a slurry (e.g., Baikalex, Rodel, etc.) having a polishing rate of 17 micron in 62 minutes with respect to the copper layer under polishing pressure of 6psi. *Curry, II et al*, however, does not suggest a polishing rate of at least 10,000 Å/min under polishing pressure of 0.1 to 2psi. Nevertheless, such excessively-low polishing pressure is known in the semiconductor polishing art as evidenced in Brigham et al disclosing “a downforce employed [to polish a Cu interconnect] can be as low as 1 psi” (¶ 0035); “the polishing rates ... are typically about 6000 to about 11,000 Å/min” (¶ 0037); “other types of suitable slurries include those using the diluent organic solvents such as propylene carbonate and mono and polyhydric alcohols” (¶ 0023).

It would have been obvious to one having ordinary skill in the art to have modified the polishing pressure and the polishing rate of *Curry, II et al* by utilizing the high polish rate of copper at low downforce because the CMP pad (which is normally used to polish) operates with more of a horizontal energy force than a vertical energy force (since there is less downward motion and the CMP involves a circular/orbital motion of a wafer under a controlled downward pressure), thereby avoid scratching the copper surface (¶ 0008).

4. Claims 3 and 5 is rejected under 35 U.S.C. 103(a) as being unpatentable over *Curry, II et al*, as applied to claims 1 and 4, in view of *Brigham et al* (US 2003/0073593), and further in view of *Tsuchiya et al* (US 6,530,968).

The combination of *Curry, II et al* and *Brigham et al* does not suggest using polycarboxylate polymer slurry. *Tsuchiya et al* teaches a slurry containing a thickener of polycarboxylate polymer [Abstract and claim 12 in *Tsuchiya et al*].

It would have been obvious to one having ordinary skill in the art to have modified the fabricating method of *Curry, II et al* by utilizing a slurry including polycarboxylate polymer for the purpose of forming an interconnect with excellent properties at a higher polishing rate.

5. Claims 6, 9, and 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over *Curry, II et al* and *Brigham et al*, in view of *Kunishima et al* (US 2004/0014312).

The combination of *Curry, II et al* and *Brigham et al* is silent about first and second copper seed layers. Nevertheless, such interconnect with plating copper layers having their underlying copper seed layers is known in the semiconductor processing art as evidenced by *Kunishima et al* disclosing first and second copper seed layers **24b** and **30** underlying their respective copper layers

**66b** and **32** [Fig. 5], and sequentially removing the second copper layer **32** and the second copper seed layer **30** to expose a surface of a second sacrificial layer pattern **18** [page 8].

It would have been obvious to one having ordinary skill in the art to have modified the interconnect of *Curry, II et al* by utilizing extra copper seed layers for the purpose of reducing diffusion of copper ions from the overlying copper interconnects.

6. Claim 7 is rejected under 35 U.S.C. 103(a) as being unpatentable over *Curry, II et al* and *Brigham et al*, as applied to claim 6, in view of *Kunishima et al*, and further in view of *Lee et al*.

The combination of *Curry, II et al*, *Brigham et al*, and *Kunishima et al* does not suggest the sacrificial layer patterns including a photoresist pattern. *Lee et al* (US 6,054,659) discloses “photoresist **38** was spun on the wafer. After patterning the photoresist sacrificial layer ...” [Fig. 2F and col. 5, ln.40].

It would have been obvious to one having ordinary skill in the art to have modified the fabricating method of *Curry, II et al* by utilizing sacrificial patterns of photoresist because a sacrificial layer pattern being of a photoresist pattern is capable of withstanding low heat treatment.

7. Claim 8 is rejected under 35 U.S.C. 103(a) as being unpatentable over *Curry, II et al* and *Brigham et al*, as applied to claim 6, in view of *Kunishima et al*, and further in view of *Tsuchiya et al*.

The combination of *Curry, II et al*, *Brigham et al*, and *Kunishima et al* does not suggest using polycarboxylate polymer slurry. *Tsuchiya et al* teaches a slurry containing a thickener of polycarboxylate polymer [Abstract and claim 12 in *Tsuchiya et al*].

It would have been obvious to one having ordinary skill in the art to have modified the fabricating method of *Curry, II et al* by utilizing a slurry including polycarboxylate polymer for the purpose of forming an interconnect with excellent properties at a higher polishing rate.

8. Claims 6 and 11-13 are rejected under 35 U.S.C. 103(a) as being unpatentable over *Curry, II et al* and *Kunishima et al* (US 2004/0014312) in view of *Brigham et al* (US 2003/0073593).

The combination of *Curry, II et al* and *Kunishima et al* teaches a method for polishing the first and second copper seed layers through a CMP process, in which a slurry having a polishing rate of 17 micron in 62 minutes with respect to the copper layer under polishing pressure of 6psi. *Curry, II et al* and *Kunishima et al*, however, does not suggest a polishing rate of at least 10,000 Å/min under polishing pressure of 0.1 to 2psi. Nevertheless, such excessively-low polishing pressure is known in the semiconductor polishing art as evidenced in *Brigham et al* disclosing “a

downforce employed [to polish a Cu interconnect] can be as low as 1 psi" (§ 0035); "the polishing rates ... are typically about 6000 to about 11,000 Å/min" (§ 0037); "other types of suitable slurries include those using the diluent organic solvents such as propylene carbonate and mono and polyhydric alcohols" (§ 0023).

It would have been obvious to one having ordinary skill in the art to have modified the polishing pressure and the polishing rate of *Curry, II et al* by utilizing the high polish rate of copper at low downforce because the CMP pad (which is normally used to polish) operates with more of a horizontal energy force than a vertical energy force (since there is less downward motion and the CMP involves a circular/orbital motion of a wafer under a controlled downward pressure), thereby avoid scratching the copper surface (§ 0008).

#### ***Response to Arguments***

9. Applicant' arguments that "Curry discloses al column 5, lines 52-57 polishing using a slurry a 6psi, by which a 17 micron copper/polvimide layer was removed in 10 minutes (17,000Å/min), which is not the same as removing only a copper layer. From the example experiment discussed in Curry it is unknown what proportion off the copper/polyimide layer is polyimide, and how the polvimide affects the polishing rate with respect to the polishing layer" is persuasive.

Applicant also argued that none of the cited references teach "a photoresist layer as a sacrificial layer" Examiner has a newly cited reference *Lee et al* '659, which reads on the shortcoming feature.

Please note also in the rejection above, that the specific portions of *Curry, II et al* and *Brigham et al*, relied upon by the Examiner to reject claims 1, 4, and 6, have been pointed out.

Any inquiry concerning this communication from the Examiner should be directed to *Calvin Lee* at (571) 272-1896, Monday to Thursday, from 6:30 to 4:00 (ET). If attempts to reach the examiner by telephone are unsuccessful, Art Unit 2825's Supervisory Patent Examiner *Matthew Smith* whose telephone number is (571) 272-1907.

Any inquiry relating to the status of this application should be directed to the Group receptionist whose telephone number is (703) 308-0596. The central fax number is (703) 872-9306 for all communications to be entered (e.g., amendments, remarks, IDS, etc.)

CL

September 30, 2004

*C. Everhart*  
CARIDAD EVERHART  
PRIMARY EXAMINER